

# **TOPIC INSPECTION PACK FOR HSAOs**

## **Rosin based solder fume: Controlling inhalation exposure to rosin based solder fume**

**Disease Reduction Programme (DRP)  
2007/2008**

**Version 1 – January 2007**



## 1. PURPOSE OF THE INTERVENTION

- 1.1 HSE has established a Disease Reduction Programme (DRP) as part of the FIT3 Strategic Programme. The DRP aims to achieve a reduction in the incidence of work-related ill-health caused by exposure to hazardous agents, this includes the common causes of occupational asthma. The aim is to achieve a **10%** reduction in new cases of occupational asthma by 2007/08 compared with the 2003/04 baseline.
- 1.2 HSE statistics (**2004/05**) showing incidence rates of occupational asthma reported by chest physicians puts rosin based solder flux fume in the top ten.
- 1.3 To support this initiative, HSAO and HSE inspectors will inspect electronics companies concentrating on control of exposure to rosin based solder fume.
- 1.4 This inspection pack provides information for HSAOs for raising awareness and for deciding if enforcement is required in this area (enforcement will be undertaken by Band 4 inspectors).

## 2. KEY MESSAGES

- Substitute with a rosin free solder **or** if this is not possible a solder wire with a minimum rosin content;
- Minimise fume generation during hand soldering by minimising the operating temperature of the solder iron;
- Install effective LEV at the soldering station; .
- Ensure appropriate training and instruction are given on the use of the solder irons, solder machines and controls;
- Implement health surveillance

## 3. WHAT THE LAW REQUIRES

- 3.1 Rosin based solder flux fume (RBSFF) is a hazardous substance under COSHH 2002 (as amended) and has been assigned both a “sen” notation and a “skin” notation indicating it is capable of causing both occupational asthma and skin sensitisation. RBSFF has Work Place Exposure Limits (WELs) of:
  - 50 ug/m<sup>3</sup> – 8 Hr time weighed average (full shift exposure averaged over eight hours); and
  - 150 ug/m<sup>3</sup> – 15 minute TWA (15-minute reference period)
- 3.2 Exposure to substances that cause occupational asthma should be reduced as low as is reasonably practicable (ALARP) below the WELs (COSHH Reg 7.7 (c) (ii)). This is achieved by following the principles of good control practice set out in Schedule 2A of the Regulations – see Appendix 1 for details.

## 4. ENFORCEMENT MANAGEMENT MODEL (EMM)

EMM was introduced to help inspectors reach a proportionate enforcement decision. It is used to determine the risk gap and inform risk-based compliance decisions. It also provides guidance regarding the Initial Enforcement Expectation (IEE), taking account of the available legal and technical guidance.

In terms of the EMM, occupational asthma is described as a serious health effect. The benchmark standard is set as nil or negligible risk. For exposure to rosin based solder flux fume, this can be achieved by:

- a) Substituting the use of rosin based solders with rosin free solders or solder free processes); **OR**
- b) Using a solder with minimum rosin content;
- c) Reducing the amount of rosin based solder fume generated at source by reducing the process temperature;
- d) Providing extracted enclosures at solder machines and hand solder stations or other effective LEV equipment (as described in COSHH Essentials sheet W17 (Appendix 2), Aide memoire (Appendix 3) and the exposure matrix (Appendix 4);
- e) Providing training, information and instruction on good work methods and use of engineering controls;
- f) Using suitable RPE alongside other control measures where appropriate (e.g. soldering the interior of cabinets and scraping off the solder slag at solder machines-reflow or wave);
- g) Providing gloves and overalls to avoid skin contact; and
- h) Providing health surveillance for occupational asthma and dermatitis (as described in COSHH Essentials sheets G402 and G403 - see Appendix 2).

Using EMM, exposures above the WELs for rosin based solder fume gives an **extreme risk** gap. To accommodate ALARP, exposure at the WELs for RBSF will produce a **substantial risk** gap. Extreme and substantial risks gaps have an initial enforcement expectation of an Improvement Notice.

## 5. INSPECTION GUIDELINES

### 5.1 GENERAL INFORMATION

Rosin based solder flux fume is generated when rosin based solder flux is heated. During hand soldering the fume rises vertically on thermal currents created by the heat of the iron, entering the breathing zone of the worker as they lean over their work. The quantity of fume emitted will depend on a number of variables including: the rosin content; the solder temperature; and the size, spread and number of joints being worked.

Assuming substitution is not possible and the lowest rosin content solder flux for the job as been selected the main emphasis is to optimise the solder temperature and to provide effective extraction. Solder machines should always be enclosed and extracted. Whilst for hand soldering the extraction control solutions will depend on:

- the soldering temperature,
- the soldering time,

- the size, spread and number of joints being worked,
- the shape of the workpiece,
- the size of the work area; and
- the number of people soldering per period.

The exposure matrix for hand soldering can be used to select the extraction likely to control exposure to the rosin solder fume (see Appendix 4).

## 5.2 VISIT SELECTION

HSAOs are asked to visit SMEs in the following SIC codes:

30010	Manufacture of office machinery
30020	Manufacture of computers and other information processing
31100	Manufacture of electric motors, generators and transformers
31620	Manufacture of other electrical equipment not classified elsewhere
32100	Manufacture of electronic valves and tubes and other electrical components
32201	Manufacture of telegraph and telephone apparatus and equipment
32202	Manufacture of radio and electronic capital goods
32300	Manufacture of television and radio receivers, sound or video recording or reproducing apparatus and associated goods
33100	Manufacture of medical and surgical equipment and orthopaedic appliances
33201	Manufacture of electronic instruments and appliances for measuring, checking testing...
33301	Manufacture of electronic industrial process control equipment

In particular, you should focus on firms

- Who routinely carry out soldering;
- That have not been visited in last 2 years or those with existing RCIs of 3 and 4; and
- Where local knowledge has identified significant asthma risks

## 5.3 VISIT RECORDING

Record what you found, the action taken and the reasons). **Use the key words DRP “rosin based solder fume 2007”**

## 6. INSPECTION TIPS

### 6.1 AIDE MEMOIRE

See appendix 3 which gives a list of questions and shows photographs of different types of extraction controls which you may encounter.

### 6.2 ASSESSMENT OF PAPERWORK

Many businesses are unlikely to have much written down. However, you should ask to see copies of:

- COSHH / risk assessments (if > 5 employed);
- Health surveillance records (or summaries) to verify it is being conducted
- Test records for thorough examination of extraction equipment (COSHH Reg 9 - at least every 14 months);

- Any written instructions provided to employees covering:
  - ✓ Health hazards (i.e. asthma and dermatitis);
  - ✓ Signs and symptoms relating to asthma and dermatitis;
  - ✓ Procedure for reporting signs and symptoms;
  - ✓ Good work methods (e.g. controlling the temperature of the solder iron);
  - ✓ How to use and maintain any extraction provided (e.g. cleaning extraction tube on tip solder iron)

### 6.3 OTHER HEALTH RISKS YOU MAY ENCOUNTER

- **Dermatitis** – rosin based solder flux wire may cause dermatitis (see G403) and Skin at Work.

## 7. RISK CONTROL INDICATORS

The three most relevant indicators to measure performance against are set out below. **However, Inspectors should bear the following factors in mind when dealing with occupiers and tailor their approach accordingly.**

**(a) Management** – there is evidence of effective organisation and arrangements including adequate COSHH assessments, provision of information, training and supervision and evidence of management commitment.

**A score of 1 if all above are in place. A score of 4 where enforcement is required. Scores of 2 or 3 where enforcement may be appropriate**

**(b) Control Strategy** – there is evidence that substitution has been considered and effected where possible, effective engineering controls have been provided and maintained, suitable RPE is provided, worn correctly (face fit test undertaken where appropriate). Appropriate training provided regarding process controls, work methods and use and maintenance of engineering controls/RPE.

**A score of 1 where hierarchical approach to control has been taken, and exposure to Solder fume has been either prevented or adequately controlled to a level as low as reasonably practicable. A score of 4 - enforcement is required. Scores of 2 or 3 where enforcement may be appropriate**

**(c) Health Surveillance** – a competent person provides health surveillance. If there are any concerns regarding competency of a health provider you will need specialist advice and support.

**A score of 1 should be allocated where health surveillance is provided. A score of 4 where enforcement is required. Scores of 2 or 3 where enforcement may be appropriate.**

## **8. FURTHER GUIDANCE**

- Controlling Health risks from rosin (colophony) based solder fluxes IND(G)249L;
- Solder fume and you INDG248 (rev); -
- HSE website section on solder fume;
- Sector Information Minute – SIM 03/2007/05;
- Preventing asthma at work :how to control respiratory sensitisers', L55, ISBN 0 7176 06619, £6.25

## APPENDIX 1 – PRINCIPLES OF GOOD PRACTICE

COSHH Regulations 2002 (as amended) – Eight principles of good practice for the control of exposure to substances hazardous to health.




### COSHH Regulation 7(7) – Schedule 2A







a)	Design and operate processes and activities to minimise emission, release and spread of substances hazardous to health
b)	Take into account all relevant routes of exposure – inhalation, skin absorption and ingestion – when developing control measures
c)	Control exposure by measures that are proportionate to the health risk
d)	Choose the most effective and reliable control options which minimise the escape and spread of substances hazardous to health
e)	Where adequate control of exposure cannot be achieved by other means, provide, in combination with other control measures, suitable personal protective equipment
f)	Check and review regularly all elements of control measures for their continuing effectiveness
g)	Inform and train all employees on the hazards and risks from the substances with which they work and the use of control measures
h)	Ensure that the introduction of control measures does not increase the overall risk to health and safety

## **APPENDIX 2 – COSHH ESSENTIALS - DIRECT CONTROL SHEETS**






- WL17-“Soldering: hand held with lead based, rosin cored solders”
- G402- Health Surveillance for Occupational Asthma
- G403- Health Surveillance for dermatitis


**APPENDIX 3- AIDE MEMOIRE FOR STAFF VISITING PREMISES USING ROSIN BASED SOLDER**

	Issues you need to find out about	Photograph/Reference	Yes	No	Comments																				
1	Are rosin based solders used? <b>(Ask to see the MSDSs-look in Section 2)</b>	<div data-bbox="645 336 1314 368" style="border: 1px solid black; padding: 2px;">2. <i>Composition/ Information on Ingredients</i></div> <table border="1" data-bbox="645 421 1314 639"> <thead> <tr> <th>Chemical name</th> <th>% (w/w)</th> <th>CAS no.</th> <th>EC Number</th> <th>Classification (See Section 16 for explanation)</th> </tr> </thead> <tbody> <tr> <td>tin</td> <td>37-40</td> <td>7440-31-5</td> <td>231-141-8</td> <td></td> </tr> <tr> <td>rosin</td> <td>1-5</td> <td>8050-09-7</td> <td>232-475-7</td> <td>Xn R43</td> </tr> <tr> <td>lead</td> <td>57-60</td> <td>7439-92-1</td> <td>231-100-4</td> <td>Repr; Cat 1 R61 - Repr Cat 3:R62 -R33 - Xn R20/22;</td> </tr> </tbody> </table>	Chemical name	% (w/w)	CAS no.	EC Number	Classification (See Section 16 for explanation)	tin	37-40	7440-31-5	231-141-8		rosin	1-5	8050-09-7	232-475-7	Xn R43	lead	57-60	7439-92-1	231-100-4	Repr; Cat 1 R61 - Repr Cat 3:R62 -R33 - Xn R20/22;			
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2	What processes are used? 1) hand soldering; and or 2) machine based –reflow or wave soldering <b>(observe the processes)</b>																								
3	Are management and users aware that exposure to rosin based solder fume can cause occupational asthma? <b>(speak to the employees)</b>																								
4	If machine based soldering is used: 1) what precautions do they take for people maintaining machinery, including 'dedrossing' (ie scraping off the solder slag) 2) do they use hand soldering for re-work (to repair defects on boards)?	 																							

	Issues you need to find out about	Photograph/Reference	Yes	No	Comments
5	If hand soldering is conducted: 1) how many people solder? 2) for how long (on an average day)? 3) Are temperature controlled solder irons units used? 4) Do they check the operating temperature of the iron using a temperature probe?	See exposure matrix (Appendix 4)  			
6	What is the general ventilation like? <b>(fume will build up more quickly in a small, low ceiling room with no windows than in a large airy workshop)</b>				
7	What other extraction is in place?  1) free standing displacement units? <b>(these should not be used);</b>  2) on iron extraction	    			



	Issues you need to find out about	Photograph/Reference	Yes	No	Comments
9	<p>If on iron extraction is provided the extract nozzle will block quickly and it will require the operator cleaning the extraction tube at least every half hour of usage, to allow it to work effectively.</p> <p>1) Is the extraction tube and flexible tubing cleaned? 2) How frequently are they cleaned?</p>	<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;">  <p>Condensed rosin on nozzle</p> </div> <div style="text-align: center;">  <p>This 50p size amount of solder blocked the tube in 10 mins</p> </div> </div> <div style="text-align: center; margin-top: 20px;">  <p>Unblocking the nozzle</p> </div>			
10.	<p>1) Has the LEV been thoroughly examined and tested in the last 14 months? 2) If the extracted air is filtered and recirculated how frequently is the filter changed?</p>	<div style="display: flex; justify-content: space-around;"> <div style="text-align: center;">  </div> <div style="text-align: center;">  </div> </div>			
11.	<p>Speak to the employees to ascertain what information instruction and training they have received on:</p> <p>1) the health risks associated with the rosin solder fume, 2) good control practices (eg temp of the solder iron) and 3) use of any extraction provided; 4) use of any PPE provided</p>				

	Issues you need to find out about	Photograph/Reference	Yes	No	Comments
12.	Speak to the supervisor to identify what their role is in checking compliance with: <ol style="list-style-type: none"> <li>1) good control practices,</li> <li>2) use of any extraction controls;</li> <li>3) Use of PPE.</li> </ol>				
13.	<ol style="list-style-type: none"> <li>1) Does the company have any health surveillance systems in place? (describe)</li> <li>2) Are employees encouraged to report early symptoms? <b>(Ask the employees)</b></li> </ol>				
14.	Ask to see the following paperwork: <ol style="list-style-type: none"> <li>1) RA if &gt;5 employees (although unlikely to have an assessment);</li> <li>2) HS records;</li> <li>3) LEV Reg 9 thorough examination records</li> <li>4) Instructions for employees on: health risks (asthma and dermatitis; procedures for reporting signs and symptoms; work methods; and use of controls.</li> </ol>				

## **APPENDIX 4 - EXPOSURE MATRIX FOR SELECTING AN APPROPRIATE EXTRACTION SYSTEM FOR HAND SOLDERING OF ROSIN-CORED SOLDER**

### **Purpose of the exposure matrix**

1. There are a several different types of exhaust ventilation controls applied to solder fume exposure control. They vary in effectiveness and it is important, for protecting people's health, that the correct system is selected, applied and maintained. To select the appropriate exhaust ventilation system an employer needs to have a reasonable understanding of the potential exposure of people soldering and a good appreciation of the likely effectiveness of the different types of solder fume exhaust ventilation systems available. Problems occur, and people's exposure is inadequately controlled and their health is put at risk, when there is a mismatch between the soldering processes to be controlled, the potential solder fume exposure and the potential effectiveness of the exhaust ventilation controls chosen. To protect people's health it is vital that the exhaust ventilation controls cope with and controls the solder fume exposure challenge. The matrix described has been developed as an aid to selecting the appropriate exhaust ventilation system.
2. The exposure matrix is a simple and easy-to-use guide to the type of ventilation likely to adequately control rosin based solder flux fume exposure for the purpose of complying with the Control of Substances Hazardous to Health (COSHH) Regulations 2002 (as amended).
3. This guidance will help in selecting different ventilation controls, **but** to comply with COSHH Regulations you must consider other aspects of COSHH. These include carrying out a suitable and sufficient assessment of risks, ensuring the controls are adequate, use and maintenance of controls, health surveillance, and provision of instructions, information and training to workers. Also, always consider whether it may be possible to substitute rosin-cored solder with a non-rosin cored alternative.

### **Information on the exposure matrix**

4. The exposure matrix shown in Table 1 is based upon three main factors that affect exposure to rosin solder fume:
  - 1) the amount of fume generated - determined mainly by the solder temperature, the size of the solder joint; number and spread of joints and the number of people soldering;
  - 2) the potential of the process to cause solder fume exposure- determined mainly by the soldering location, relative to the operator and the shape of workpiece being soldered; and
  - 3) the exposure time - determined by the total solder time.
5. There are three exposure categories for rosin solder fume described in Table 1. Categories 1, 2, or 3 give exposure scores of 1, 2 and 3 or 5 respectively, A

higher score indicates a greater fume hazard or exposure risk. The total scores given by the matrix lead to different recommended ventilation control solutions.

6. The matrix is based on measured exposures in different circumstances and the suggested solutions have been checked against workable controls based on these measurements.

### **Terms used in the exposure matrix**

7. To obtain the information required for the matrix it is necessary to both talk to the solder operators and observe them soldering. If the soldering process or work conditions vary between operators, Table 1 will need to be completed for each operator. If people are doing similar operations then the potential exposure should be assessed against "Worst case" conditions and the control approach suggested applied to all. If people are doing different soldering operations then it might be feasible to apply different types of control approaches to each. However, in practice it may make sense to rationalise controls to one type even if in some cases people might be 'over-protected'.
8. The following text explains the terms used in the exposure matrix.
  - (a) Solder Temperature: The operating temperature will primarily depend on the melting point of the solder wire. The solder station should be fitted with a temperature control facility which should inform you of the operating temperature. Place the temperature in one of the three ranges:
    - Less than 220 °Celsius;
    - Between 220-290 °Celsius;
    - Greater 290°Celsius
  - (b) Total solder time (per day): the total time spent in a day soldering.
    - (i) intermittent exposure which totals less than 15 minutes implies that the operator spends brief periods throughout the day soldering the odd few joints;
    - (ii) 15-60 minutes implies that the operator either spends a single intense period soldering or a few periods a day;
    - greater than 60 minutes a day implies the solder operator spends much of the day doing some soldering.
  - (c) Size of joints- determined by the gauge of the wire.
    - Small less than 0.7mm diameter wire;
    - medium less than 1.6mm;
    - large-greater than 1.6mm/desoldering
  - (d) Spread and number of joints

- (e) Shape of workpiece- the workpieces may vary from an open PCB board to the interior of a box/cabinet . The latter may result in the operator's face being within or close to the open face of the box/cabinet.
- (f) Work environment in which soldering is conducted:
- Poorly ventilated- a very small and restricted work area with no natural ventilation which will result in rapid build up of fume
  - Well ventilated- for example, a spacious work area with a high ceiling and with good natural ventilation via doors, windows and gaps in the building structure
  - Moderate ventilation- conditions lie with the two extremes
- (g) Number of people soldering per period- determine by the number of soldering stations in the work room.

### **Using the exposure matrix**

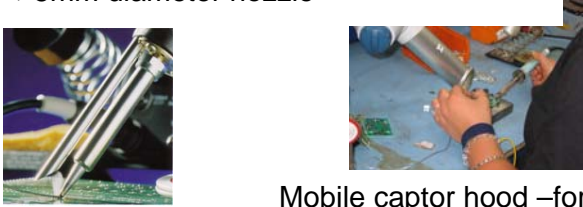

Follow the simple steps described below to find a ventilation control approach.

**STEP 1** (Table 1) There are 6 entries, a-f, in the 'process parameters' column in Table 1. For each process parameter decide which exposure category best describes the conditions during soldering.

**STEP 2** (Table 1) Record the score for each process parameter in the 'exposure score' box. For example, if your answer for parameter 'a' soldering temperature , was '240 degrees celcius this is in column '2' and scores 2 in box 'a'. Add up the 6 scores to give the total exposure score.

**STEP 3** (Table 2) Using the exposure score from Table 1, find the ventilation system required from Table 2.

<b>Table 1-Exposure Matrix for soldering using rosin cored solder wires</b>					
<b>PROCESS PARAMETERS</b>		<b>EXPOSURE CATEGORIES</b>			<b>COMMENTS</b>
		<b>Most Exposure</b>	<b>Moderate Exposure</b>	<b>Least Exposure</b>	
		<b>Score 5</b>	<b>Score 2</b>	<b>Score 1</b>	
a	Solder Temperature	Greater 290	220- 290	Less 220	
b	Total soldering time (per day)	Greater than 60 minutes	15-60 minutes	Intermittent soldering –total duration less than 15 minutes	
c	Size of joints	Large	Medium	Small -	
		<b>Score 3</b>	<b>Score 2</b>	<b>Score 1</b>	
d	Spread of joints/ number of joints	closely spaced/large	Moderately spaced/moderate number	Widely spaced/small number	
e	Shape of workpiece	Cabinet	Awkward shape	Open PCB	
f	Size of work area eg (spacious/crowded/ low/high ceiling)	Small/ Crowded/confined /low ceiling	Moderate size	Spacious/ high ceiling	
g	Number of people soldering per period	6+	3-6	1-3	
<b>Total Exposure Score ( a+b+c+d+e+f+g) =</b>					

<b>Table 2-Selecting a control approach based on total exposure score for hand soldering</b>		
<b>Total exposure Score</b>	<b>Ventilation Control Approach</b>	
Less than or equal 10	<ul style="list-style-type: none"> <li>• Minimum –Good natural ventilation</li> <li>• If natural ventilation poor (eg well sealed work area –planned powered mechanical ventilation will be required</li> </ul>	
11-14	<ul style="list-style-type: none"> <li>• Minimum – local exhaust ventilation (LEV) (eg well designed and applied mobile captor hood or on iron extraction)</li> </ul>	<p>On iron extraction with a &gt;5mm diameter nozzle</p>  <p>Mobile captor hood –for small PCBs</p>
Greater or equal 15	Work done in a partial enclosure (ie a cabinet or hood)	

<b>Table 3- Summary of Extraction systems for Hand Soldering</b>			
<b>Type of Extract System</b>	<b>Description</b>	<b>Advantages</b>	<b>Disadvantages</b>
Multi-position or flexible arm Extraction	A captor hood attached to the end of an adjustable, flexible ducting. Proper design and position of hood is critical to effective fume capture. The ducting maybe attached to a stand-alone extraction filtration system or a multi-branch system	<ol style="list-style-type: none"> <li>1) Ability to set at an optimum position;</li> <li>2) Flexibility in installation;</li> <li>3) Ease and frequency of maintenance;</li> </ol>	<ol style="list-style-type: none"> <li>1) Reliance on correct adjustment to the work by the operator</li> <li>2) Applications where the arm needs to be continually moved over a wide area</li> <li>3) Restricting movement of the operator and the work-piece at the workstation</li> <li>4) Failure to control fume from components when removed from the work position;</li> </ol>
Tip Extraction	Uses a narrow bore tube (typically 4 -12mm) on the solder iron to capture fume at source. Careful attention should be given to the design of the tip or nozzle and extraction rates for effective fume capture	<ol style="list-style-type: none"> <li>1) Continuous removal of fume from the iron while in use or at rest;</li> <li>2) Easy installation;</li> <li>3) Minimal volume/flow rate of air avoiding</li> <li>4) Significant heat loss</li> <li>5) Little change to soldering operations needed</li> </ol>	<ol style="list-style-type: none"> <li>1) Blockage of the narrow bore tubes with sticky residues requiring regular and frequent maintenance and cleaning;</li> <li>2) Failure to control fume from components when removed from the work position;</li> <li>3) Less effective for wide spread fume production or where there is rapid movement or soldering iron around the work- piece</li> </ol>
Fume extraction cabinets	Enclosures with one open side or the front connected to either a stand alone or a multi-branch extraction system. Available in a variety of sizes and shapes. Will control fume from soldering operation and any residual fume given off from hot soldered joint.	<ol style="list-style-type: none"> <li>1) Ability to control all fume sources within the enclosure;</li> <li>2) Relatively low maintenance needs;</li> <li>3) No reliance on correct adjustment by operator</li> <li>4) Potentially very effective control of fume emissions and escape</li> </ol>	<ol style="list-style-type: none"> <li>1) Lack of flexibility in installations;</li> <li>2) Possibly poor accessibility (if not well designed);</li> <li>3) Significant installation and running costs;</li> <li>4) Possible need for local lighting</li> </ol>